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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Model simulations with COSMO-SPECS: Impact of heterogeneous freezing modes and ice nucleating particle types on ice formation and precipitation in a deep convective cloud" *by* Karoline Diehl and Verena Grützun

**Anonymous Referee #2**

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The manuscript presents model simulations of deep convective clouds, using the 3D cloud resolving model COSMO-SPECS with an improved parameterization of ice forming processes. The effects of small changes in different heterogeneous freezing modes on ice formation, cloud microphysical properties and precipitation are investigated, the latter with respect to the time of occurrence, spatial distribution and total amount. In general the manuscript provided by Diehl and Grützun aims the scope of ACP and is scientifically relevant for the atmospheric science community.
The manuscript is well structured and I had hardly any issued with the approach and



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style of presentation. I appreciate the extensive experiments conducted and the detailed presentation of the results, and I have only some minor questions and comments.



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Minor comments:

- The effects of latent heat release due to phase change are not discussed. As stated in Grützun et al., 2008 this may become important for the development of the cloud, with respect to updraft velocities. Are there significant difference between the different model runs used in this study?

- Would your findings be applicable in terms of cloud seeding of e.g. severe thunderstorms by the reduction of total precipitation amount and/or more equal temporal and spatial distribution of precipitation?

- Abstract, page 1, line 23 – 24: Be more specific here, e.g. mention that an enhancement/reduction of more than 20% in total precipitation amount was found for different freezing modes/particle types.

- Page 2, line 15 – 16: How large is the fraction of homogeneously formed ice? Could you add an example with a reference (e.g. the reference from page 8, line 4 – 5).

- Page 2, line 27: Are "the most important INP types" referring exclusively to deep convective cloud? If so, please specify here. Up to date it is not solved which are the "most important INP type" for all cloud types, e.g. the importance of biological INP in the free troposphere is questioned, and marine aerosols might have a global contribution in remote areas.

- Page 6, line 5 – 6: In the presented work it is not considered that biological ice-nucleating active macromolecules (INMs) as small as 10 nm can be released

from their carriers, e.g. from pollen and fungal spores, upon contact with water, and can be released in much higher concentrations. Thus they can have a much higher atmospheric implication as previously assumed. Would an increased biological/pollen concentration influence your results, resp. would you expect a larger effect of biological particles, and which effect would this have on the importance of different freezing modes and could this finally influence precipitation modification?

- Page 11, line 3: Is the term “similar” justified here, since an enhancement/reduction of 20% was observed?

- Page 15, line 19 – 22: I find this statement confusing, since earlier on it is mentioned that deviations in the total precipitation amount was $\pm$ 20%. Did you perform statistical tests to come to the conclusion that this is not a significant difference? Also you are concluding that “precipitation may be determined mainly by cloud dynamics”, as an outcome of the updraft velocities up to 40 $ms^{-1}$. This is somewhat contradicting your chosen model setup to study effects on precipitation by cloud microphysics. To be coherent I would rather conclude that, although you have the strong dynamical component, cloud microphysics still can influence precipitation.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-570, 2017.



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